25. (AMENDED) The apparatus defined in claim 23 further comprising means to change the shape of the ~~partially saturated~~casing area at near practical saturation~~.~~

26. (TWICE AMENDED) The apparatus defined in claim 23 further comprising means to modify the relative permeability of the ~~partially saturated~~ casing at near practical saturation.

27. (AMENDED) The apparatus defined in claim 23 further comprising means to modify the ~~partially saturated~~ casing at near practical saturation in relation to the saturation of the casing proximate to one or more receivers.

PROVISIONAL DOUBLE PATENTING

Please enter the terminal disclaimers to obviate a provisional double patenting rejection applicable to pending applications 09/716,340 and 09/946,692.

REMARKS

THE REJECTION OF CLAIMS UNDER 35 U.S.C. §112, 2nd PARAGRAPH

The Examiner has objected to the text of the specification on the basis that it is not clear what the Applicant means by the term "partial saturation." The Examiner states that a material is either saturated or unsaturated. It is the position of the Applicant that established technical literature recognizes that a material may be subjected to a magnetic flux density such that its permeability is significantly lowered, but that it is not completely saturated. This term has been used to describe the state of material at the upper knee of the BH curve. See for example the text Introduction to Electric Circuits, 4th ed. Jackson, at page 211-212, stating practical saturation is "the flux density beyond which it is impractical to magnetize a certain magnetic material."

Please also note that this identical issue was believed to have been satisfactorily resolved with the Examiner in this manner in the prosecution of

application serial number 09/946692, with Notice of Allowance mailed January 15, 2003. Consistent with that understanding, the Applicant has amended the claims as described above. The Applicant respectfully submits that the claims 23 through 30, as amended, should now be in order for allowance.

The Examiner has rejected claim 35 as failing to disclose the purpose of measuring the conductivity of the casing proximate to the logging tool in induction logging. The Examiner has also rejected claim 36 as failing to disclose the need to measure the permeability of the casing proximate to the apparatus while the casing is stature to reduce its permeability to zero.

It is the position of the Applicant that one aspect of its invention is the ability to receive electromagnetic signals through electrically conductive and magnetically permeable materials. These materials have traditionally been barrier materials to such signals. It is also known that the conductivity and permeability properties varying among differing material. Further, materials that may otherwise be identical may have differing properties due to variations in the manufacturing process. Therefore, in evaluating the information of a geologic formation derived from electromagnetic signals transmitted through electrically conductive and magnetically permeable material, the conductivity or permeability may be important variables for consideration. Accordingly, it is the Applicant's position, that each claim, read by a person skilled in the technology and in conjunction with the specification, does disclose the purpose of the claim elements. (It is noted that this issue was subject of the Examiner's First Office Action. Therefore, the Applicant intends to contact the Examiner by telephone to obtain a better understanding of the rejection.)

In regard to the Examiner's objection to the drawings not disclosing the embodiment of the invention subject of claim 22, please note that claim 22 states:

> "(AMENDED) The apparatus defined in claim 1 wherein a plurality of saturation inducers, transmitters and receivers are

oriented in different directions radially from the axial length of the casing."

It is the Applicant's position that Figures 8 and 30 each illustrate a plurality of inducers, transmitters and receivers oriented in different radial directions. Figure 8 illustrates two sets of 4 saturation inducers **501** oriented radially 90° to the other. Also the upper set of 4 saturation inducers each is used in conjunction with a separate transmitter **300**. The lower set of 4 saturation inducers are each used in conjunction with four separate receivers **580**. Similarly, Figure 30 illustrates a set of 6 saturation inducers **500A** – **500E** oriented radially about a well casing **100**. The Figure shows that each inducer **500** can be used in conjunction with one or both of a transmitter **300** or receiver **580**. Both Figures 8 and 30 illustrate the "axial length of the casing" sufficiently for a person skilled in the technology. Therefore, it is the Applicant's position that elements of claim 22 are described by the specification and drawings, particularly when the specification and drawings are read as a whole.

THE REJECTION OF CLAIMS FOR PROVISIONAL DOUBLE PATENTING

In regard to the Examiner's provisional rejection for provisional double patenting, the Applicant has executed the required terminal disclaimers. It should be noted that notice of allowance has been received for both applications.

THE REJECTION OF CLAIMS UNDER 35 U.S.C. §103

As to the Examiner's rejection of claims under 35 U.S.C. Section 103, it is the intent of the Applicant to discuss the basis of the rejection by telephone conference. It is the Applicant's belief that it has already responded to many, if not all, of the issues stated in the Examiner's February 18, 2003 office action. It is respectfully suggested that the Applicant may not appreciate or fully understand the basis of the Examiner's rejections.

In addition, the Applicant traverses the Examiner's assertion that it would have been obvious to a person skilled in the art to configure a saturating inducer for engaging the magnetic flux with a portion of the casing without electrical contact between the saturating inducer and the casing for improving the logging tool. It is the Applicant's position that Gianzero patent teaches away from the Applicant's invention of in view of Gianzero's express teach of the need for a good electrical contact between the well casing and the sensor device. The Examiner has not provided any reference to art suggesting or pointing to the teaching of the Applicant's invention. Further, claims 2 through 42 are dependant upon Applicant's claim 1. The Applicant respectfully suggests, inter alia, that having acknowledged that all elements of claim 1 are not taught by Gianzero, the Examiner may not use the Gianzero patent alone to reject the Applicant's invention for obviousness.

The Examiner has correctly drawn the Applicant's attention to Figure 15 of Gainzero, along with the accompanying text appearing in column 11, beginning at line 55 and continuing to column 12, line 12. However, it remains the position of the Applicant that the two transmitter coils, driven in phase, are for markedly differing purposes than the Applicant's invention of a saturating coil and a separate second and higher frequency oscillating transmitter coil.

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Response to Office Action
Serial No. 09/781,667
Group Art Unit: 2862

SUMMARY

The Applicant has revised the specification and claims consistent with its past understanding of the Examiner regarding "near practical saturation." The Applicant has also executed the terminal disclaimers required to remove the provisional double patenting rejection. The Applicant will contact the Examiner to directly discuss the continued rejection of claims for §103 obviousness.

Respectfully Submitted,

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Date: May 19, 2003

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited on May 19, 2003 with the Untied States Postal Service, postage prepaid, as Express Mail – Post Office to Addressee, in an envelope addressed to the MS Non-Fee Amendment, Commissioner of Patents, P.O. Box, 1450, Arlington, VA. 22313, Mailing Label No. EU441112634US.

David McEwing
Registration No. 37,026

Serial No. 09/781,667
Filed February 12, 2001
Applicant: Bijan Amini

REVISED PARAGRAPHS OF SPECIFICATION WITHOUT MARKUP

Pg 3, line 7

C1

"The Logging Tool of this invention creates a Metallic Transparency"™ local to its oscillating magnetic flux transmitter (Transmitter) and its flux signal receiver (Receiver) by means of a strong magnetic flux field saturating the proximate portion of the Barrier Material comprising the Well Casing near the Transmitter and Receiver. It may also utilize creating near practical saturation and Magnetic Lensing to direct the oscillating flux of the Transmitter in a controlled manner."

Page 8, line 23

C2

"There are a plurality of subsystems that may be incorporated into the invention. These include the following:

Full Saturation Magnetic Flux Circuit
Near Practical Saturation Magnetic Flux Circuit
Transmitter/Receiver System
Nulling System – geometric, electronic, permeability
Automatic Lensing System
Conductivity/Resistivity Measurement System
Wall Thickness Measurement System"

Page 12, line 23

C3

"The present invention includes the creation of transparencies or windows (Metallic Transparencies"™ within such Barrier Materials comprising the Well Casing, thereby allowing the passage of oscillating magnetic flux into or through the Well Casing. In simple terms, the invention works in the following steps: (1) a Saturation component (Saturation Inducer or Magnetic Transparency Generator) containing a "Saturation Coil", preferably wrapped around a highly permeable core ("Saturation Core"). When the Saturation Coil is energized, it acts as an electromagnet. The

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Saturation Coil creates one or more fields of magnetic flux ("Saturation Current" or "Saturation Flux") adjacent or near the Well Casing. The Saturation Flux engages with the adjacent Well Casing and creates full magnetic saturation or near practical saturation of the Well Casing proximate to the Saturation Coil. Saturation results in the magnetic permeability of the Well Casing being substantially lowered. When fully saturated, that portion of the Well Casing cannot absorb further magnetic flux, thereby allowing additional flux to pass through the Well Casing. When at near practical saturation, the Well Casing acquires greater capacity to engage or couple with magnetic flux, especially magnetic flux oscillating at relatively high frequencies. In such a state, that portion of the Well Casing has become "transparent" to magnetic flux. This section at full saturtion or at near practical saturation is known as a "Transparency" or a Metallic Transparency). (2) One or more magnetic flux transmitter components ("Transmitters"), each utilizing one or more coils ("Transmitter Coil") located proximate to a Metallic Transparency, then create one or more fields of additional magnetic flux oscillating at frequencies preferably equal to or greater than the Saturation Flux. This oscillating magnetic flux ("Transmitter Signal," "Sensing Signal" or "Transmitter Flux") is engaged with the section of fully saturated casing or section at near practical saturation (having greatly reduced magnetic permeability) allowing the Transmitter Flux (or other oscillating magnetic flux induced by eddy currents within the Casing at near practical saturation) to pass through the Metallic Transparency of the Well Casing and enter the surrounding geological formation. (3) Electrically conductive media, e.g., water or hydrocarbon, contained within the surrounding formation interact with this oscillating magnetic flux. Through basic electromotive forces, a separate oscillating magnetic flux is induced in the electrically conductive media contained within the formation. (4) The field of this induced magnetic flux extends back to the Well Casing. As in step No. 1 above, the same or similar Saturation Coils create a Transparency near a separate coil ("Receiver Coil") so that the induced magnetic flux of the geologic formation can be received and measured by this Receiver Coil located inside the Casing. (5) The Receiver component, of which the Receiver Coil is part, converts the induced flux ("Receiver Signal") into electrical signals ("Reciever Current") that are filtered and

processed in order to determine the electrical resistivity of media located in the geologic formation proximate to the Well Casing. The Receiver Signal is electrically processed to concentrate and magnify the induced oscillating magnetic flux, thereby forming the Receiver Signal. The Transmitter Flux (or Transmitter Signal) is nulled to minimize direct transmission of flux from the Transmitter to the Receiver. The Transmitter Signal is compared to the Received Signal and, using the changes in amplitude and phase, the electrical resistivity of the media in the surrounding geologic formation is determined and displayed. These signals may then be sent to the Output display for further processing, display, and recording. The Output display, power supply, and other ancillary equipment may be located at the well head or surface."

C3

Page 15, line 1

"As will be discussed in greater detail below, the preferred embodiment of the invention will include the ability to generate and send a plurality of Transmitter Flux of differing frequencies, either simultaneously or sequentially. The preferred embodiment will also include the ability to detect and measure Receiver Signal from a plurality of directions. A preferred embodiment will also have the capability to create near practical saturation of one or more portions of the Well Casing in order that one or more frequencies of oscillating magnetic flux may be induced in and focused or directed through a portion of Well Casing at near practical saturation utilizing Magnetic Lensing™."

C4

Page 15, line 16

"It will be appreciated that there is a plurality of components or subsystems in the invention.

These include the following:

Full Saturation Magnetic Flux Circuit

Near Practical Saturation Magnetic Flux Circuit

C5

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Serial No. 09/781,667
Filed February 12, 2001
Applicant: Bijan Amini

C3 end

Transmitter/Receiver System

Nulling System – geometric, electronic, permeability

Automatic Lensing System

Conductivity/Resistivity Measurement System

Wall Thickness Measurement System"

Page 16, line28

C6

"2. Near Practical Saturation Magnetic Flux Circuit

When in a state of partial saturation, the effected portion of the Well Casing can be used for Magnetic Lensing. Simply stated, when at near practical saturation, the permeability of the Casing is substantially reduced, thereby allowing greater penetration by the oscillating Transmitter Signal, particularly at higher frequencies. However, the relative permeability of the Casing is greater than 1 weber/amp. The Casing at near practical saturation continues to absorb a significant portion of the Transmitter Signal. Since the Casing is also electrically conductive, eddy currents are generated within the Casing. Oscillating magnetic flux induced by the eddy currents is emitted from the Casing into the geologic formation. The reduced permeability can be utilized to control and concentrate this induced magnetic flux emitted from the Casing at near practical saturation. This Casing therefore acts as a lens to concentrate and direct oscillating magnetic flux transmitted into the surrounding geologic formation. This allows measurement of the electrical resistivity of media within the formation and more distant from the Well Casing than can be achieved by controlling the separation distance between the Transmitter and Receiver."

Page17, line ~~28~~ 18

C7

"If a Partially Transparent volume region is created, a separate oscillating EM wave is transmitted into this Partially Transparent volume region, preferably of a higher frequency than the first EM energy source. Eddy currents are generated in the Partially

C

Transparent Material. An oscillating magnetic flux is induced by these eddy currents. At least some portion of the magnetic flux from this induced magnetic field is transmitted out from the Partial Barrier Material. However, the lines of flux are bent or altered as they are emitted out from the surface of the Material at near practical saturation into the surrounding environment. This bending of magnetic flux can be controlled, allowing the lines of magnetic flux to be focused on an Object existing on the opposite side of the Barrier Material from the MTG transmitter. This focusing partially counteracts the normal rapid geometric spreading of magnetic flux. Concentrating the magnetic flux allows distant sensing using much less power. When utilized in this manner, the MTG includes a Magnetic Lens™ capability."

C7

Page 19, line10

"3. Minimizing possible saturation of the Saturation Inducer core that would cause uncontrolled dispersion of Saturation Flux. The dispersed Saturation Flux may create only near practical saturation of a selected portion of the Well Casing. This may be a desired result. This is exactly opposite the concern cited in U.S. Patent No. 5,038,107 which does not want to use an AC current on the Saturation Inducer Core that may take the walls or core out of saturation."

C8

Page 25, line 15

"The Saturation Flux **401** may not achieve the level of current (flux density) necessary to saturate the targeted area of the EM barrier material comprising the Casing. However, when at near practical saturation, the Casing will allow a significantly greater portion of the distinctively higher frequency Transmitter Signals **411** to couple, i.e., penetrate, into the Well Casing to generate eddy currents within an area of near practical saturation or, alternatively, be of sufficient magnitude to saturate a portion of the Well Casing when combined with the Saturation Flux and therefore allowing the Transmitter Signal to directly penetrate through the Casing. In another embodiment, the

~~C9~~ replace w/ new C9

"If a Partially Transparent volume region is created, a separate oscillating EM wave is transmitted into this Partially Transparent volume region, preferably of a higher frequency than the first EM energy source. Eddy currents are generated in the Partially Transparent Material. An oscillating magnetic flux is induced by these eddy currents. At least some portion of the magnetic flux from this induced magnetic field is transmitted out from the Partial Barrier Material. However, the lines of flux are bent or altered as they are emitted out from the surface of the ~~Partially Saturated~~ Material at near practical saturation into the surrounding environment. This bending of magnetic flux can be controlled, allowing the lines of magnetic flux to be focused on an Object existing on the opposite side of the Barrier Material from the MTG transmitter. This focusing partially counteracts the normal rapid geometric spreading of magnetic flux. Concentrating the magnetic flux allows distant sensing using much less power. When utilized in this manner, the MTG includes a Magnetic Lens™ capability."

Page 19, line10

"3. Minimizing possible saturation of the Saturation Inducer core that would cause uncontrolled dispersion of Saturation Flux. The dispersed Saturation Flux may ~~achieve~~ create only near practical saturation ~~partial saturation~~ of a selected portion of the Well Casing. This may be a desired result. This is exactly opposite the concern cited in U.S. Patent No. 5,038,107 which does not want to use an AC current on the Saturation Inducer Core that may take the walls or core out of saturation."

Page 25, line 15

"The Saturation Flux **401** may not achieve the level of current (flux density) necessary to saturate the targeted area of the EM barrier material comprising the Casing. However, when ~~partially saturated~~at near practical saturation, the Casing will allow a significantly greater portion of the distinctively higher frequency Transmitter Signals **411** to couple, i.e., penetrate, into the Well Casing to generate eddy currents

C9

C

within an area of ~~partial saturation~~near practical saturation or, alternatively, be of sufficient magnitude to saturate a portion of the Well Casing when combined with the Saturation Flux and therefore allowing the Transmitter Signal to directly penetrate through the Casing. In another embodiment, the Transparency Current may be generated from at least one permanent magnet, a low frequency AC current or a direct current DC electromagnetic device."

C9 cont.

Page 27, line 8

"With reference to the preceding abbreviated outline of the invention and Figure 1, the invention comprises the following steps and utilizes the referenced components and sub-components: (1) the Saturation Coil 551, when energized, acts as an electromagnet. The Saturation Coil creates one or more fields of magnetic flux adjacent or near the Well Casing (not shown). The Saturation Coil creates a section at near practical saturation ~~partial~~ or at full magnetic saturation within at least a portion of the Well Casing immediately proximate to the Saturation Coil 551. Saturation results in the magnetic permeability of the Well Casing being substantially lowered. When fully saturated, that portion of the Well Casing cannot absorb further magnetic flux, thereby allowing additional flux to pass through that portion of the well casing. In such a state, that portion of the Well Casing has become Metallically Transparent to magnetic flux. In order to create a full Metallic Transparency, the full saturation must extend through the thickness of the Casing. (2) The Transmitter 300 then creates one or more fields of additional magnetic flux having frequencies preferably equal to or greater than the saturation flux. The second field of magnetic flux is engaged with the section of full saturation or at near practical saturation ~~or partial saturation~~ (having greatly reduced magnetic permeability) allowing the Transmitter flux to pass through the Transparency of the Well Casing and enter the surrounding geologic formation. (3) Media in the interact with the oscillating magnetic flux created by the Transmitter 300. Through basic electromotive forces, a separate oscillating magnetic flux is induced in the electrically conductive media. (4) The induced magnetic flux travels back to the Well Casing. As in

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step No. 1 above, the same or similar Saturation Coils 551 create a Transparency near the Receiver 580 so that the induced magnetic flux can be detected and measured through the Casing. (5) The Receiver converts the induced flux into electronic signals that are filtered and processed in order to determine the resistivity of media located outside the Casing. The received signal is processed using various electronic components (which may be located within the Electronic Component 570) to concentrate and magnify the reacted oscillating magnetic signal. The invention may contain means 582 to electronically null the Transmitter Flux to minimize direct transmission of flux from the Transmitter 300 to the Receiver 580 and to minimize the interference of electronic noise. The transmitted signal is compared to the received signal and, using the changes in amplitude and phase, the resistivity is determined and displayed. These signals are then sent to the Output Display 583 for further processing, display, and recording."

Page 34, line 25

"For the reasons stated previously, it will be appreciated that the Transparency Current can not be allowed to saturate the Flux Circuit Core 552. Further, the Transmitter Current will generate eddy currents in the Flux Circuit Core. Further it will be appreciated by persons skilled in the art that the greatest saturation will occur along the circumference of the Flux Circuit Core in as much as the permeability of the ~~near saturated or partially saturated~~ Flux Circuit Core <u>at near practical saturation</u> will be lowest at the circumference, i.e., edge of the cylinder. Since the permeability of the Barrier Material will approach the permeability of air, the angle of refraction of the magnetic flux (not shown) induced by the eddy current within the Flux Circuit Core will increase from the perpendicular. It will be further appreciated that this configuration has created or utilized Magnetic Lensing capacity within the Magnetic Transparency Generator. This configuration also is a preferred embodiment due to its compact size, energy efficiency, accuracy of measurement and ability to utilize Magnetic Lensing. Figure 22 also illustrates the placement of a Receiver Coil 580 nulled to the Transmitter

Coil 300."

Page 37, line 8

"As previously mentioned, when a gap is present, e.g., insulation causing the space between the Saturation Core 552 and Well Casing 110, the wrapping of the Transmitter 300 on the Core 552 utilizes this gap to create the Magnetic Lensing effect at the surface of the Saturation Core, analogous to the Lensing that can be created at the Well Casing surface ~~using partial saturation~~<u>at near practical saturation</u>. This Magnetic Lensing counteracts the decreasing Transmitter Flux, i.e., the decrease in the Transmitter Flux density as the distance from the Transmitter or Saturation Core increases. The rate of this decrease in Transmitter Flux density is the inverse cube of the gap distance between the Saturation Core interface to the Well Casing. This is illustrated by the relationship of magnetic flux intensity decreasing to zero as the inverse cubed of the distance (D) 910 away from the surface, i.e., Intensity Plot = 1/D3. Note that in this example, the Transmitter is located on the Saturation Core. It will be appreciated by persons skilled in the art that the Saturation Core concentrates the Transmitter Flux. It will be appreciated that in the preferred embodiment of the invention, a ferromagnetic material or other electrically conductive and magnetically permeable material ("EM Barrier") is used for the Magnetic Lensing component."

Page 38, line 20

"In Figure 13A, the Transmitter Coil 300 is rotated to be approximately parallel to the Casing 110, ignoring temporarily that the Well Casing surface is necessarily curved in forming the cylindrical shape. The Transmitter induced eddy currents 620 generate the magnetic flux field having a geometry illustrated by field lines 140-143. Note the density of the magnetic flux field lines along line 910 as the flux field emerges from the ~~partially saturated~~<u>surface of the</u> Casing <u>at near practical saturation</u> ~~surface~~ 110. Supplemented on the Figure 13A is the plot 181 of the decrease in magnetic field

intensity 180 as the distance from the surface 910 increases. The magnetic flux field intensity 180 decreases to zero along the plotted line 181. This illustrates that the intensity decreases in relation to the distance (D) 910 away from the surface, i.e., Intensity Plot = 1/D3."

Page 45, line 15

"The second step in calculating the thickness of a material with unknown permeability and conductivity is the approximation of permeability. Using the same Transmitter, Receiver, and saturation procedures described in the first step, a Saturation Flux is generated near or close to the Well Casing to be measured. The Saturation Flux has a known yet variable current. A Transmitter Flux of known and constant frequency and amplitude is generated at or near the Well Casing within a zone to be effected by the Saturation Flux. A Receiver monitors the Receiver Signal from the transmitted signal returning for generating a resulting electromagnetic response. While monitoring the received response and holding the Transmitter Flux frequency and amplitude constant, the Saturation Current is increased incrementally. Thus, the Receiver Signal will generally mirror the steps of the Saturation Flux but at different amplitudes than the Transmitter Flux. (See Figures 21B and 21C.) As the Saturation Flux increases, the Well Casing becomes more and more transparent to the Transmitter Flux (maintained at constant amplitude and frequency), thus, causing the amplitude of the Receiver Signal to increase proportional to the stepped increases in the Saturation Flux. The stepped incremental saturation is continued while the Transmitter Flux is held at the constant amplitude and frequency and the resulting increments in the Receiver Signal are monitored. This is continued until no further changes are registered by the Receiver in response to increases in the Saturation Flux. The point at which the received signal registers no change may be called "total saturation." See Figure 21C. Once Total Saturation is achieved, increases in the current or amplitude of the Saturation Flux have no effect upon the Received Signal. Thus, the Transmitter Flux is coupled with the Casing. As the Casing becomes more saturated, (and its permeability

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approaches 1) the Casing becomes increasingly transparent, resulting in more of the Transmitter Flux penetrating though the Casing. The current history and the associated received signal, as illustrated in Figure 21A, 21B and 21C, provide for fully saturating or creating a near practical saturation ~~or partial saturation~~ of a localized area. Further, the current history and the received signal information can be used to mathematically determine the permeability and thickness. Once approximation is obtained on either permeability or conductivity, the other variable can be determined and the material thickness can then be calculated."

C

S/N 09/781,667
Filed February 11, 2001
Applicant Bijan Amini

REVISED CLAIMS

C10

22 ~~23~~. (TWICE AMENDED) The apparatus defined in claim 1 wherein (i) the saturation inducer engages the interior side of the casing with magnetic flux but does not saturate the casing through to the exterior side, (ii) the oscillating magnetic flux generated and transmitted by the transmitter means induces eddy currents within the portion of casing at near practical saturation, (iii) receiver detects oscillating magnetic flux generated within electrically conductive media located exterior to the casing by eddy currents induced within the media by the oscillating magnetic flux emitted from the casing at near practical staturation.

23 ~~24~~. (AMENDED) The apparatus defined in claim 22 ~~23~~ further comprising means to modify the area of the casing at near practical saturation in a controllable manner in order that the oscillating magnetic flux emitted from the exterior side of the casing at near practical saturation is directed in an intended manner.

24 ~~25~~. (AMENDED) The apparatus defined in claim 22 ~~23~~ further comprising means to change the shape of the casing area at near practical saturation.

25 ~~26~~. (TWICE AMENDED) The apparatus defined in claim 22 ~~23~~ further comprising means to modify the relative permeability of the casing at near practical saturation.

26 ~~27~~. (AMENDED) The apparatus defined in claim 22 ~~23~~ further comprising means to modify the casing at near practical saturation in relation to the saturation of the casing proximate to one or more receivers.

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Serial No. 09/781,667
Filed February 12, 2001
Applicant Bijan Amini

REVISED CLAIMS MARKED TO SHOW CHANGES

23. (TWICE AMENDED) The apparatus defined in claim 1 wherein (i) the saturation inducer engages the interior side of the casing with magnetic flux but does not saturate the casing through to the exterior side, (ii) the oscillating magnetic flux generated and transmitted by the transmitter means induces eddy currents within the portion of casing at near practical saturation, ~~partially saturated portion of the casing,~~ (iii) receiver detects oscillating magnetic flux generated within electrically conductive media located exterior to the casing by eddy currents induced within the media by the oscillating magnetic flux emitted from the ~~partially saturated~~ casing at near practical staturation.

24. (AMENDED) The apparatus defined in claim 23 further comprising means to modify the ~~partially saturated~~ area of the casing at near practical saturation in a controllable manner in order that the oscillating magnetic flux emitted from the exterior side of the ~~partially saturated~~ casing at near practical saturation is directed in an intended manner.

25. (AMENDED) The apparatus defined in claim 23 further comprising means to change the shape of the ~~partially saturated~~casing area at near practical saturation~~.~~

26. (TWICE AMENDED) The apparatus defined in claim 23 further comprising means to modify the relative permeability of the ~~partially saturated~~ casing at near practical saturation.

27. (AMENDED) The apparatus defined in claim 23 further comprising means to modify the ~~partially saturated~~ casing at near practical saturation in relation to the saturation of the casing proximate to one or more receivers.

Serial No. 09/781,667
Filed February 12, 2001
Applicant: Bijan Amini

REVISED PARAGRAPHS OF SPECIFICATION MARKED TO SHOW CHANGES

Pg 3, line 7

"The Logging Tool of this invention creates a Metallic Transparency"™ local to its oscillating magnetic flux transmitter (Transmitter) and its flux signal receiver (Receiver) by means of a strong magnetic flux field saturating the proximate portion of the Barrier Material comprising the Well Casing near the Transmitter and Receiver. It may also utilize ~~partial saturation~~ creating near practical saturation and Magnetic Lensing to direct the oscillating flux of the Transmitter in a controlled manner."

Page 8, line 23

"There are a plurality of subsystems that may be incorporated into the invention. These include the following:

Full Saturation Magnetic Flux Circuit
~~Partial Saturation~~Near Practical Saturation Magnetic Flux Circuit
Transmitter/Receiver System
Nulling System – geometric, electronic, permeability
Automatic Lensing System
Conductivity/Resistivity Measurement System
Wall Thickness Measurement System"

Page 12, line 23

"The present invention includes the creation of transparencies or windows (Metallic Transparencies"™ within such Barrier Materials comprising the Well Casing, thereby allowing the passage of oscillating magnetic flux into or through the Well Casing. In simple terms, the invention works in the following steps: (1) a Saturation component (Saturation Inducer or Magnetic Transparency Generator) containing a "Saturation Coil", preferably wrapped around a highly permeable core ("Saturation Core"). When the Saturation Coil is energized, it acts as an electromagnet. The

C

Saturation Coil creates one or more fields of magnetic flux ("Saturation Current" or "Saturation Flux") adjacent or near the Well Casing. The Saturation Flux engages with the adjacent Well Casing and creates ~~a partial or~~ full magnetic saturation or near practical saturation of the Well Casing proximate to the Saturation Coil. Saturation results in the magnetic permeability of the Well Casing being substantially lowered. When fully saturated, that portion of the Well Casing cannot absorb further magnetic flux, thereby allowing additional flux to pass through the Well Casing. When at near practical saturation, ~~partially saturated,~~ the Well Casing acquires greater capacity to engage or couple with magnetic flux, especially magnetic flux oscillating at relatively high frequencies. In such a state, that portion of the Well Casing has become "transparent" to magnetic flux. This section at full saturation or at near practical saturation ~~partially or fully saturated section~~ is known as a "Transparency" or a Metallic Transparency). (2) One or more magnetic flux transmitter components ("Transmitters"), each utilizing one or more coils ("Transmitter Coil") located proximate to a Metallic Transparency, then create one or more fields of additional magnetic flux oscillating at frequencies preferably equal to or greater than the Saturation Flux. This oscillating magnetic flux ("Transmitter Signal," "Sensing Signal" or "Transmitter Flux") is engaged with the section of fully saturated casing or section at near practical saturation ~~or partial saturation~~ (having greatly reduced magnetic permeability) allowing the Transmitter Flux (or other oscillating magnetic flux induced by eddy currents within the ~~partially saturated~~ Casing at near practical saturation) to pass through the Metallic Transparency of the Well Casing and enter the surrounding geological formation. (3) Electrically conductive media, e.g., water or hydrocarbon, contained within the surrounding formation interact with this oscillating magnetic flux. Through basic electromotive forces, a separate oscillating magnetic flux is induced in the electrically conductive media contained within the formation. (4) The field of this induced magnetic flux extends back to the Well Casing. As in step No. 1 above, the same or similar Saturation Coils create a Transparency near a separate coil ("Receiver Coil") so that the induced magnetic flux of the geologic formation can be received and measured by this Receiver Coil located inside the Casing. (5) The Receiver component, of which the Receiver Coil is part,

converts the induced flux ("Receiver Signal") into electrical signals ("Reciever Current") that are filtered and processed in order to determine the electrical resistivity of media located in the geologic formation proximate to the Well Casing. The Receiver Signal is electrically processed to concentrate and magnify the induced oscillating magnetic flux, thereby forming the Receiver Signal. The Transmitter Flux (or Transmitter Signal) is nulled to minimize direct transmission of flux from the Transmitter to the Receiver. The Transmitter Signal is compared to the Received Signal and, using the changes in amplitude and phase, the electrical resistivity of the media in the surrounding geologic formation is determined and displayed. These signals may then be sent to the Output display for further processing, display, and recording. The Output display, power supply, and other ancillary equipment may be located at the well head or surface."

Page 15, line 1

"As will be discussed in greater detail below, the preferred embodiment of the invention will include the ability to generate and send a plurality of Transmitter Flux of differing frequencies, either simultaneously or sequentially. The preferred embodiment will also include the ability to detect and measure Receiver Signal from a plurality of directions. A preferred embodiment will also have the capability to create near practical saturation of ~~partially saturate~~ one or more portions of the Well Casing in order that one or more frequencies of oscillating magnetic flux may be induced in and focused or directed through a portion of ~~partially saturated~~ Well Casing at near practical saturation utilizing Magnetic Lensing™."

Page 15, line 16

"It will be appreciated that there is a plurality of components or subsystems in the invention.

These include the following:

Full Saturation Magnetic Flux Circuit

Near Practical Saturation ~~Partial Saturation~~ Magnetic Flux Circuit

Transmitter/Receiver System

Nulling System – geometric, electronic, permeability

Automatic Lensing System

Conductivity/Resistivity Measurement System

Wall Thickness Measurement System"

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"2. Near Practical Saturation ~~Partial Saturation~~ Magnetic Flux Circuit

When in a state of partial saturation, the effected portion of the Well Casing can be used for Magnetic Lensing. Simply stated, when at near practical saturation, ~~partially saturated,~~ the permeability of the Casing is substantially reduced, thereby allowing greater penetration by the oscillating Transmitter Signal, particularly at higher frequencies. However, the relative permeability of the Casing is greater than 1 weber/amp. The ~~partially saturated~~ Casing at near practical saturation continues to absorb a significant portion of the Transmitter Signal. Since the Casing is also electrically conductive, eddy currents are generated within the Casing. Oscillating magnetic flux induced by the eddy currents is emitted from the Casing into the geologic formation. The reduced permeability can be utilized to control and concentrate this induced magnetic flux emitted from the ~~partially saturated~~ Casing at near practical saturation. ~~The partially saturated~~This Casing therefore acts as a lens to concentrate and direct oscillating magnetic flux transmitted into the surrounding geologic formation. This allows measurement of the electrical resistivity of media within the formation and more distant from the Well Casing than can be achieved by controlling the separation distance between the Transmitter and Receiver."

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